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### Modelling consumer behaviour

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# 2 The commons dilemma

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## Introduction

Man's relation with ecosystems is a double-faced one. On the one hand we depend on ecosystems as resources for food, building materials and a healthy environment to live in. On the other hand we often plunder and pollute ecosystems as if we were independent from them. This often results in the depletion of natural resources. The central question here is why people bite the hand that feeds them. In this chapter the commons dilemma paradigm will be used to explain the management of natural resources. The research traditions in this field as well as an inventory of experimental results will be presented. Finally, some limitations of the research in this paradigm are being discussed.

Economists were one of the firsts to put resource depletion on the agenda. In the late 18<sup>th</sup> and early 19<sup>th</sup> century, Malthus, Ricardo and Mill all concluded that scarcity of natural resources could lead to diminishing returns, and thus to a reduction in economic growth (Norton, 1984). According to Malthus (1789), land resources were a limiting factor to feed the increasing population. Ricardo (1817) distinguished different types of land, and argued that first land of the best quality is used, before land of a lower quality is used, a process leading to increasing marginal costs of increasing land use. According to Mill (1848) resource productivity could be maintained or even improved through technological development.

The arguments from the early days of economics still hold in the current discussions on the limits to growth (e.g., Köhn, Gowdy, Hinterberger and Van der Straaten, 1999). Since renewable resources play an important role in this monograph, resource economics will be discussed in more detail. A renewable resource, such as a fish stock, has a maximum carrying capacity depending on the environmental conditions. Changes in environmental conditions may change the carrying capacity of the resource. The maximum sustainable yield of a renewable resource is the maximum possible harvest that would not reduce the size of the resource after its renewal (e.g., restoration of fish-stock, regeneration of timber that is harvested).

From a classical economic perspective however, one is not interested in this sustainable yield but in the level of extraction (e.g., harvest, catch) that maximises the returns on investments. The optimal level of extraction is the level where the marginal costs equal the marginal returns from extraction. If one considers extraction during a number of periods, economists are interested in maximising the present value of extraction, that is the discounted stream of costs and benefits from the efforts to extract. Since discounting is dependent on returns from other investments, depletion of the renewable resource is likely when re-investing the revenue from resource extraction is more profitable, e.g., fishermen investing their revenues in better ships. When more agents have access to the resource, the situation becomes that of a common property. Here the individual agents are not primarily concerned with their marginal effect on the resource, but with the actual returns from extraction they derive for themselves. This leads to a higher extraction rate, which increases the chance of biological depletion, but certainly

results in economic over-fishing (Norton, 1984, p.119). This focus on individual returns causes for example that many private owned ships are put in service to exploit fish-grounds, whereas the collective revenue would be higher if fewer ships would return with a higher catch.

The *commons dilemma* describes situations where the individual and collective rationalities in determining an optimal resource use collide. A commons dilemma starts from the perspective of the resource, addressing environmental problems in terms of their behavioural causes. In a commons dilemma a collective opportunity exists for all individuals to consume. If this collective opportunity has a certain growth capacity, we may conceive it as a renewable resource. If such a resource, e.g., fresh water or natural forest, is being consumed at a rate that overshoots its natural growth, the availability of the resource will decrease. If consumption remains at a high level, the resource may even cease to exist. The risk of exhaustion is determined both by the consumption of the resource and the growth capacity of the resource. A certain limitation to the consumption of the resource is required to preserve it for a longer time, allowing its consumption to be sustainable. Many environmental issues where no property rights exist on a certain exhaustible resource can be understood as a commons dilemma. Examples are ocean fishing, waste dumping, fresh water consumption and forest management.

The commons dilemma paradigm has proven to be fruitful in describing a variety of situations where individual and collective interests collide. Such conflicts between individual and collective interests have intrigued scientists since Machiavelli (1525), who addressed this issue in the context of the political consequences of social (in)equality. Hardin's (1968) frequently cited article on the commons dilemma describes how this conflict affects the management of collective resources, explaining why people often tend to overexploit them. In his article Hardin (1968, p. 1244) presented the story of the decline of the common pastures for herding cattle. This story originates from a publication of Lloyd (1833). The story is told in the following way:

*The tragedy of the commons develops in this way. Picture a pasture open to all. It is to be expected that each herdsman will try to keep as many cattle as possible on the commons. Such an arrangement may work reasonably satisfactory for centuries because tribal wars, poaching, and disease keep the numbers of both man and beast well below the carrying capacity of the land. Finally, however, comes the day of reckoning, that is, the day when the long-desired goal of social stability becomes a reality. At this point, the inherent logic of the commons remorselessly generates tragedy.*

*As a rational being, each herdsman seeks to maximize his gain. Explicitly or implicitly, more or less consciously, he asks "What is the utility to me of adding one more animal to my herd?" This utility has one negative and one positive component.*

- 1) The positive component is a function of the increment of one animal. Since the herdsman receives all the proceeds from the sale of an additional animal, the positive utility is nearly +1.*
- 2) The negative component is a function of the additional overgrazing created by one more animal. Since, however, the effects of overgrazing are shared by all the herdsmen, the negative utility for any particular for any particular decision-making herdsman is only a fraction of -1.*

*Adding together the component particular utilities, the rational herdsman concludes that the only sensible course for him to pursue is to add another animal to his herd. And another; and another. . . But this is the conclusion reached by each and every rational herdsman sharing a commons. Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit – in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his*

*own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all.*

Hardin (1968) uses this example to notify that for many problems no technical solutions are available. He exemplifies this with the arms-race between the east and the west that worried many people in that era, illustrating that for both parties it was more attractive to arm to increase their safety. This, however, resulted in both parties being heavily armed, constituting a more dangerous situation than had both parties restricted their military investments. Hardin (1968) specifically relates the concept of the commons dilemma to issues like the use of national parks and pollution in light of the growth of human population.

Hardin (1968) argued that the 'rational' use of a commons by many individuals cumulates to tragic overuse and depletion of the common resource. To prevent this depletion, Hardin proposes to introduce a socialistic system (central authority) or to privatise the common resource. However, these solutions are not always effective. For example, empirical studies show that the pasturelands in Russia, which has a state-owned collective agriculture, and in China, where pastureland has been privatised recently, have degraded to a much larger extent than comparable pasturelands in Mongolia, which are being managed by traditional group property institutions (Sneath, 1998). Many more examples exist of commons that are properly being managed by groups of people that have developed norms regarding the use of the resource (see e.g., Ostrom, Burger, Field, Norgaard and Policansky, 1999). These findings indicate that the management of common resources involves more complex processes than the metaphor of Hardin's commons suggests. To better understand what factors affect the management of environmental commons dilemmas, it is first necessary to make an inventory of the precise structure of the dilemma. This is being done in the next section. Following that, we will discuss research traditions in the study of the commons dilemma, and discuss a number of factors that have experimentally been found to affect harvesting behaviour in a commons dilemma.

## **The environmental commons dilemma**

The commons dilemma paradigm has been useful for understanding how people manage common resources. It has been used as a conceptual framework for understanding the processes leading towards many environmental problems, such as deforestation, over-fishing and air-pollution. Such environmental commons dilemmas are usually quite complex because of the various personal and collective outcomes involved, the specific dynamics of the resource and uncertainty about the outcomes. The people confronted with an environmental commons dilemma thus have to weigh several aspects in order to make decisions on how to behave. This weighting may be a very deliberate act, but more often it is a less conscious process. Vlek and Keren (1992) distinguish between the following four types of weightings that people have to make, which take the form of dilemmas<sup>1</sup>.

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<sup>1</sup> The text delineating these four dilemmas is based on Vlek & Keren (1992, pp. 250-251).

- 1: The everyday *benefit-risk dilemma*: if security, comfort and wealth are primary human desires, then to what extent should the level of achievable benefits be restricted to keep associated risks acceptably low? It is assumed here that benefit and risk levels across sets of human activities are correlated so that optimal benefit-risk combinations must be identified (Coombs and Avrunin, 1977).
- 2: The *temporal dilemma*: if the principal task of individuals, groups and organisations is to survive 'now', to what degree should current security, comfort and wealth be restrained in order to safeguard future survival conditions (which one may not live to see)? Or, in other words, how much attention and effort could best be devoted to short-term survival and how much is worth allocating to long-term survival?
- 3: The *spatial dilemma* underlies environmental degradation: if it is our principal task to survive here (in this place), to what extent should our local security, comfort and wealth be limited so as to secure more general survival conditions, such as the quality of seas and forest areas?
- 4: Environmental degradation can bring about a *social dilemma*: if one's principal task is to survive as an individual, then to what extent should individual security, comfort and wealth be restricted in order to maintain collective survival conditions such as public utilities, education, transport and health care?

An environmental commons dilemma can be regarded as a combination of these four dilemmas. This complex dilemma addresses the balancing of short-term local outcomes (mostly benefits) at the individual level with long-term global outcomes (mostly costs) at the collective level. The latter result from the combined externalities of many acting individuals. Assuming that consumers assign greater importance to financial and material benefits, and to present, local, and individual outcomes, the dilemmas will work as *traps*, tempting consumers to maximise their own short-term and local benefits whilst ignoring collective, long-term and global risks (Hardin, 1968; Dawes, 1980; Vlek, 1996).

An important factor regarding the character of an environmental commons dilemma is the perspective that an actor has on the dilemma. An actor may not perceive the dilemma or be insecure about the existence of the dilemma because of several reasons (e.g., Vlek, 1996). First, the actor may be unaware of the collectively damaging externalities of his behaviour. Especially when these negative externalities emerge slowly and/or in the long run, as may be the case with climatic changes, the actor is not likely to draw a relation between his behaviour and the negative collective outcomes. For example, examining information on the toxic emissions of one's car may convince one of the environmental harmlessness of one's car. However, as the emission of CO<sub>2</sub> still contributes to the greenhouse effect, the accumulation of these emissions may have a significant effect on the environment.

Second, the actor may be unaware of the seriousness of the accumulation of externalities. For example, an actor may be aware of the relation between CO<sub>2</sub> emissions and the greenhouse effect, but think that a global rise of temperature has no serious consequences for the climate.

Third, people may think that the negative collective outcomes are relatively small in comparison to the individual benefits (of many people). For example, the European policy on fisheries seems to prioritise the economical outcomes (work, income) over biological outcomes (fish populations, quality of sea-bottom) in allocating fishing quota.

Fourth, people may be aware of the collective risk, but perceive it to be the result of an autonomous development that cannot be controlled. Consequently, these people

may experience a 'no-choice' situation, and therefore do not perceive a dilemma despite their perception of the negative outcomes. For example, one may be convinced that forest-burning in order to gain agricultural land is ultimately destroying one's environment, but what else can one do if the alternative is starvation.

These points illustrate that the behaviour of people in an environmental commons dilemma both depends on the characteristics of the dilemma as well as individual characteristics. Many of these characteristics have experimentally been studied in the so-called *resource dilemma paradigm*. A resource dilemma can be considered as a specific type of commons dilemma. Basically, the resource dilemma offers each individual the choice between harvesting now a lot at the risk of exhausting the resource, versus harvesting less so as to sustain the resource. The more people harvest a lot, the quicker the resource may get exhausted. Whereas in the basic social dilemma the individual has the choice between a cooperative and a defective choice, where the cooperative choice yields the highest collective outcomes, the resource dilemma is more complex. Here, a significant restraint in personal harvesting, which can be considered to be cooperative, may not yield the highest collective outcomes. Because the resource can grow, a consumption level that is significantly lower than its growth capacity can be understood as under-using the resource (De Vries and Wilke, 1992, pp 82). Given that the growth function of the resource is known, an optimal collective harvest (OCH) can be determined. As long as the harvesting does not exceed this OCH, an increase in harvesting has no negative consequences for the resource. However, if the OCH is being exceeded, the resource will decrease and the outcomes will become smaller.

### **Research traditions in the study of the commons dilemma**

Economics, being the study of the allocation of scarce resources for the satisfaction of human needs, and the problems of choice that are involved in this allocation process, has a large tradition in the study of commons dilemmas. In the economical research of exhaustible resources, much attention has been given to the study of renewable resources, which are in principle accessible for every individual, such as fish-stocks, oil wells and clean air. Economists argue that there exist several rationalities that may guide man's use of renewable resources. For example, different types of rationality lead towards individual rationality, the Nash equilibrium, Pareto efficiency and strong equilibrium (Dasgupta and Heal, 1979). Individual rationality implies that a person is following a strategy that maximises its individual outcomes. A Nash equilibrium (Nash, 1950) holds that an individual cannot find a strategy that further improves its outcomes, provided that all the other people do not change their behaviour (an unilateral behaviour change decreases outcomes). Strong Equilibrium (Aumann, 1995) holds that no group of people can all gain by unilaterally changing their behaviour (strategies). A Pareto optimal choice implies that society as a whole is economically the best off. However, this may imply that only a few rich people experience higher outcomes, whereas poor people may be worse off, thus indicating that an economically Pareto optimal outcome may not be socially desirable (see Norton, 1984, pp. 76)

Economic research clarifies that certain rationalities, when applied to a renewable resource, may yield outcomes that are less optimal and sometimes even disastrous. For

example, individual rational behaviour may result in uneconomic harvesting behaviour, even if such behaviour does not jeopardise the resource in itself (Norton, 1984).

Much economic research is aimed at the conditions under which these different types of rationality are dominating, and what types of measures are feasible to affect this domination. Usually this involves finding the conditions that favour an optimal resource depletion rate, provided that the actors employ an optimising strategy. Moreover, it can be calculated which governmental measures are necessary to attain an optimal depletion rate, given that all agents are following such an optimising strategy. In such calculations, economists employ the 'rational actor' approach, working with the assumption of agents that have perfect knowledge and try to optimise their outcomes. This approach provides an essential back-curtain against which the fallacies of actual economic behaviour may be perceived.

Luce and Raiffa's *Games and Decisions* (1957) awakened a fascination for the conflict between individual and collective interests in many social scientists also outside the economic tradition. Where economics is generally a normative science studying the optimal way of allocating scarce resources, social psychology is more a descriptive science studying the actual decision-making of human actors. Social psychology is focussed at questions of why people do not behave in an optimal manner, and what factors play an important role in actual behaviour. Combining a social-psychological view on behaviour with the economical principles that apply to renewable resource management, may add to the understanding of the discrepancies between optimal and actual behaviour.

Game theory, originating from Von Neumann and Morgenstern (1944), formed the basis on which Luce and Raiffa (1957) developed experimental games to study the actual behaviour of people in *social dilemmas*. Formally, a social dilemma can be described as a situation in which each decision maker is best off acting in his own self-interest, regardless of what the other persons do. Each self-interested decision, however, creates a negative outcome or cost for the other people who are involved (Van Lange, Liebrand, Messick and Wilke, 1992, pp. 4). In the experimental gaming approach, subjects have to choose between a defective and a cooperative action. Because the outcomes of their choice also depend on the choice of the other subject, subjects are interdependent. The defective action yields the highest expected individual outcomes, no matter the choice of the other subject. However, if both subjects choose the defective action they both obtain lower outcomes than had they chosen the cooperative action.

Experimental games can be thought of as empirical research tools that can be used to test the predictive accuracy of the formal theory of games (Van Lange *et al.*, 1992, pp. 4). Many experiments have been performed in this experimental game tradition, using different experimental games and identifying psychological variables that affect choice behaviour in such situations (Rapoport and Orwant, 1962; Rapoport and Chammah, 1965; Deutsch, 1960; Pruitt and Kimmel, 1977; Wrightsman, O'Connor and Baker, 1972; Colman, 1982; Hamburger, 1979). Many of these experiments taught us much about the basic forces driving people's behaviour in dilemmas. However, also critique was uttered regarding the lack of mundane realism and the associated external validity of many experiments (e.g., Nemeth, 1972, Pruitt and Kimmel, 1977; Kelley and Thibaut, 1978; Hamburger, 1979; Colman, 1982; Liebrand, 1983; Liebrand *et al.*, 1992). Many experimental games involved only two subjects, whereas real dilemmas often involve large numbers of people. Often the experimental games were played in a single trial, whereas in real dilemmas people repeatedly make choices. In experimental games the subjects usually

have an identical (symmetric) harvesting ability, whereas in real dilemmas usually several abilities play a role, which often display a skew distribution (asymmetric harvesting abilities). In experimental games the subject often has to choose between a cooperative and a defective choice, whereas real dilemmas usually offer a range of possible choices.

Two paradigms that in particular tried to increase mundane realism are the *resource dilemma paradigm* (see above) and the *public goods paradigm* (see Van Lange *et al.*, 1992, pp. 11). The resource dilemma is inspired by the commons dilemma as described by Hardin (1968). In this paradigm subjects are confronted with a common resource and they have to decide how much to take from that resource. Because this experimental game may last for a prolonged period of time, people have to take the long(er)-term effects of their behaviour on the resource in account. Typical founders in this tradition are Jerdee and Rosen (1974), Rubinstein, Watzke, Doktor and Dana (1975) and Brechner (1977). The public goods paradigm, inspired by Olson (1965), structurally resembles the resource dilemma paradigm, only the subjects now have to decide how much to *contribute* to a freely accessible resource. Despite the structural resemblance between the resource dilemma paradigm and the public goods paradigm, the psychological difference is large, as is denoted by their respective names *take-some game* and *give-some game* (Hamburger, 1979). Whereas the public goods dilemma can be applied to practical situations such as tax paying, the resource dilemma appears to be the most relevant in describing man's relation with the environment.

In the following section attention is given to the results of experimental games that appear to be relevant in the context of commons dilemmas. Some of these results originate from the social dilemmas paradigm, some from the resource dilemma paradigm, and some from the public goods paradigm. However, all the experimental games touch upon the conflict between the individual and collective level that constitutes the heart of the commons dilemma. Therefore, results originating from the different experimental paradigms are being summarised conjointly.

### **Factors affecting behaviour in experimental games**

Two lines of research may be distinguished in the laboratory study of human resource management. The first line is focussed on group factors that may affect the harvesting behaviour of the individual subjects. The second line is focussed at the personal factors that affect harvesting behaviour.

A typical experiment on group factors confronts a group of subjects with a common resource, and one (or more) group factor(s) is experimentally being varied. Group factors apply to all the people in a dilemma, and refer to structural/situational characteristics of the dilemma. Examples of such factors are the possibility of direct (visual) contact with other group members, the visibility of the harvesting behaviour of others and the familiarity with others in the group. Whereas experimental games are useful in studying the effect of group factors, it is less practical for studying individual factors. Because individual factors such as a person's social orientation cannot be experimentally varied, it is virtually impossible to develop an experimental design with exactly the same distributions of person characteristics in each of the experimental conditions. Moreover, the differing individual factors may result in behavioural dynamics that are not known beforehand, and thus stand in the way of getting clear experimental results. A much used



solution for this problem is offered by the 'false feedback' procedure, in which subjects are led to believe that they interact with other subjects, but actually are interacting with computerised subjects with predisposed behavioural strategies. Because this implies that there are no real other subjects to play the game with, these are strictly spoken no experimental games. The behaviour of the other 'subjects' can be programmed beforehand, and thus is amenable to experimental manipulation. Subjects with differing individual characteristics can be confronted with the same computerised subjects, thus allowing to systematically study the effect of person factors on people's behaviour in a resource dilemma, with 'typically' behaving other subjects (e.g., all computerised others behave cooperative or defective). Below, we will first discuss a list of group factors. Thereafter, a list of personal factors affecting harvesting behaviour will be discussed.

### ***Group factors influencing behaviour in a dilemma***

The following group factors have been shown to affect the harvesting behaviour of individuals in an experimental dilemma.

- Group size. When there are more persons caught in a dilemma, the level of cooperation will decrease (e.g. Fox and Guyer, 1977). This effect typically becomes visible if the group size increases from two to about seven or eight persons. Above the eight persons it does not make a difference if there are e.g. seven or twenty persons involved in the dilemma (Liebrand, 1984). Olson (1965) recognised this effect very early and attributed it to the lower efficacy that people experience in larger groups.
- Pay-off structure of the dilemma. It is not surprising that cooperative behaviour in a dilemma is promoted by decreasing the incentive associated with noncooperative behaviour and/or increasing the incentive associated with cooperative behaviour. This was found in the classic study of Kelley and Grzelak (1972) and repeatedly found in later studies (see e.g., Van Lange *et al.*, (1992)).
- Communication in the dilemma. Several studies have been directed at the effect of communication on people's behaviour in a N-person dilemma. Some studies report that communication enhances cooperation (Jerdee and Rosen, 1974; Liebrand, 1984; Jorgerson and Papciak, 1981), whereas other studies report weak or no effects of communication (Caldwell, 1976; Loomis, 1959). The classic study of Dawes, McTavish and Shaklee (1977) showed that only communicating about what decision to make is effective in stimulating cooperative behaviour. The effect of communication may be based on the setting of a commitment norm and the enhancement of a group identity, which processes may also amplify one another (Van Lange *et al.*, 1992; Orbell, Van de Kragt and Dawes, 1988).
- Identifiability of the behaviour. Jorgerson and Papciak (1981) found that cooperative behaviour is promoted if the other people can observe one's personal choice behaviour. This effect only occurs when there is no communication. This suggests that identifiability has about the same effect as communication, namely the promotion of 'social control' to exercise personal restraint. This 'social control' mechanism may be responsible for the fact that people are more willing to work hard under conditions of high visibility than in more anonymous settings (Williams, Harkins and Latané, 1980). Group size also plays a role in the identifiability of behaviour: the larger the group, the more anonymous one is.

- Group identity. If the persons in a dilemma experience a strong group identity, they feel more responsible for the outcomes and are more inclined towards cooperative behaviour (Brewer, 1979; Edney, 1980). Brewer and Kramer (1986) showed that the effects of group identity were the strongest in large groups, suggesting that personal responsibility is more important in large groups.

### ***Personal factors influencing behaviour in a dilemma***

The following personal factors have been found to affect harvesting behaviour of individuals in an experimental dilemma.

- Personal restraint. If the persons involved in a resource management task believe that personal restraint is essential to maintain the shared resource pool (sustainable use), people are more likely to cooperate, (e.g., Jorgerson and Papciack, 1981; Samuelson, Messick, Rutte and Wilke, 1984).
- Uncertainty. The more uncertain people are regarding the size and growth, and thus the optimal collective harvest (OCH) of a collective resource (environmental uncertainty), the more people tend to harvest from that resource (Wit and Wilke, 1998; Hine and Gifford, 1996; Suleiman and Rapoport, 1989; Messick, Allison and Samuelson, 1988). It appears that people, who become less quickly uncertain following unforeseen developments in the resource growth, tend to harvest less than people who become more quickly uncertain (Wit and Wilke, 1998). This indicates that not the fluctuations of the resource, but rather the person's sensitivity for these fluctuations trigger feelings of uncertainty.
- Expectations of other persons' behaviour. The expectations regarding the behaviour of other persons is an important behaviour-determining factor (Dawes *et al*, 1977; Messick, Wilke, Brewer, Kramer, Zemke and Lui, 1983; Schroeder, Jensen, Reed, Sullivan and Schwab, 1983; McClintock and Liebrand, 1988). If one expects that most other people will cooperate, one is more likely to cooperate too. However, if one expects that many others will defect, one will avoid being the 'sucker' whose cooperative behaviour is being exploited by the defecting others. Consequently, if one expects that most others will defect, defecting oneself seems a reasonable action. Other explanations that Van Lange *et al.* (1992) mention for this expectations-choice relationship refer to the inference of social norms on the basis of one's expectations, the conformity of people, the expectation that others will do as oneself, and a *post hoc* justification for one's choice behaviour (Messé and Sivacek, 1979).
- Trust. People differ with respect to the degree to which they trust other people (Yamagishi, 1988). People having a high trust in others are more willing to cooperate. People with a low trust in other people will be less likely to cooperate. Moreover, with respect to policy strategies to resolve a dilemma it appears that people low on trust are more in favour of a sanctioning system that imposes sanctions on noncooperative choices (Van Lange *et al.*, 1992, p. 17).
- Social Value Orientation. The social value orientation of a person, defined as preference for a particular distribution of outcomes for oneself and others, is an important behaviour-determining factor in social dilemmas (Messick and McClintock, 1968; McClintock, 1978). Whereas in principle eight typical social value orientations exist, the three empirically most frequent occurring orientations have been the topic of theorising and empirical study. These three orientations are (1) cooperation, aimed at maximising the outcomes of self and the other, (2) individualism, aimed at maximising

one's own outcomes, and (3) competition, aimed at maximising one's own outcomes in contrast to others' outcomes. An important conclusion from research on social value orientations is that not all people are *a priori* inclined to value only their own outcomes, or to see the pursuit of self interest as rational (Van Lange *et al.*, 1992, p.17). Including the outcomes of others in some way in a subjects own outcome matrix leads to a transformed outcome matrix, which may yield other optimal choices than pure self-interest would prescribe (Kelley and Thibaut, 1978; Kuhlman and Marshello, 1975; McClintock and Liebrand, 1988).

- Personality factors. Extraversion and agreeableness are personality factors affecting the harvesting behaviour in a resource dilemma (Koole, Jager, Van den Berg, Vlek and Hofstee, in press). Under the condition of a depleting resource it was found that people high on extraversion and/or low on agreeableness tend to harvest significantly more.
- Personal responsibility. Personal responsibility is a factor which is somewhat related to identifyability (Van Lange *et al.*, 1992, p. 20). A classic study by Latané and Darley (1968) showed that people are less helpful when more people are involved. The idea is that the more people are involved, the more the responsibility for the outcomes is diffused across the members of the group. Fleishman (1980) found that people felt more responsible the more others depended on one's contribution. Moreover, people who felt responsible contributed more, which suggests that responsibility enhances cooperative behaviour.
- Morality. People tend to cooperate more if they previously discussed the morality of cooperation and immorality of defecting (Dawes, 1980). The morality of (non)cooperation is often a topic of discussion in groups involved in a dilemma (Dawes, McTavish and Shaklee, 1977). Individuals who perceive the social dilemma as a moral issue tend to cooperate more often (Van Lange, Liebrand and Kuhlman, 1990).

### **Limitations of the experimental gaming research**

The previously mentioned experiments represent only a small part of the large number of studies that have been conducted in the field of social dilemmas, resource dilemmas and public goods. Empirical studies in this field taught us a lot about the factors that influence human behaviour in a dilemma. However, the laboratory setting of this research differs significantly from real-world dilemma situations. A first difference deals with the time scale of the dilemma. Whereas experimental games in a laboratory setting seldom exceed a time limit of one hour, in the real world, negative collective outcomes (extinction of a resource) may occur only after several years, decades, or even generations. This raises questions regarding time-discounting effects in real world dilemmas. Wit, Wilke, Van Der Geest, Hofstra and Vahrenkamp (1996) experimented with two generations of players that were managing a collective resource. They found that people in the first generation only restrain their consumption when their outcomes were made dependant of the outcomes the next generation obtained. This suggests that people will only restrain their harvesting behaviour when they find it important that their successors can harvest at the same level as themselves. In practice this restriction will especially occur when the successors are children, family or members of the same tribe, clan or people.

Second, real world dilemmas usually involve large numbers of people. Whereas in experimental games the number of subjects seldom exceeds a dozen<sup>2</sup>, in the real world hundreds, thousands and millions of people can be caught in the same type of dilemma. When global warming is regarded as a negative outcome of the intensive energy-use of many people, it may be concluded that the world population as a whole is being caught in a commons dilemma. The laboratory-fact that above a number of seven or eight subjects a further increase in the number of subjects does not result in lower cooperation suggests that this factor is not relevant in discriminating between large and very large dilemmas (e.g., thousands versus millions of people). However, as far as we know, empirical research has not been directed at such large groups, and it can be postulated that in a group of thousand people it will be easier to address group characteristics such as communality and culture than in groups of millions.

A third difference refers to the type and relevance of outcomes. In the experimental games the outcomes usually are framed in terms of credit points or money, and depending on the number of points the subjects collected they will receive more or less money at the end of the experiment. The size of the monetary reward will usually have no significant effects on the subjects' daily lives. In the real world the outcomes are usually much more diverse and significant. For a fisherman in a developing country the catching of more fish yields more money, which can be spent on e.g., better fishing equipment, education for his children or luxury items. Catching less fish may result in poorer living circumstances for his family. Another example is a rich person living, e.g., in California, who consumes a lot of energy for transportation (large car, travelling by air), climate control of the home and household appliances. A serious decline in his energy use implies a change of activities that will have negative consequences for his social life, the comfort of his house and his social status. These outcomes are very personal, direct and clear, whilst the negative outcome of global warming is very general, to be expected in the future and relatively uncertain as is indicated by the vivid discussions in the scientific community on the seriousness of the enhanced greenhouse effect. These examples show that in comparison to experimental games, real life dilemmas confront people with choices that involve important outcomes. Moreover, these outcomes are multidimensional in the sense that the satisfaction of several needs depends on the behaviour people perform. Whereas the choices that people make while playing an experimental game usually have no far-reaching consequences for their lives, in real-life dilemmas the choices one makes may determine one's quality of life to a far extent.

These three limitations have stimulated several researchers to employ behaviour simulation models in their research to tackle the points discussed above. Two main directions can be distinguished in the application of simulation models. First, several researchers tried to increase the realism of natural resource systems by developing computer simulations of more complex systems. Such simulations provide a tool to study the behaviour of people in more realistic yet controllable situations, thereby compressing long-term processes in short experimental simulation sessions. Second, several researchers developed simulations of behaviour itself, operationalising agents via algorithms that represent certain decision processes. This approach allows for testing different algorithms against each other, and to evaluate these in terms of the sustainability of the underlying processes. Moreover, this approach allows in principle for experimentation with far-

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<sup>2</sup> The study of Fleishman (1980) reporting a N of 100 seems to be one exception.

reaching outcomes, such as famines when a food resource is being over-harvested, and the 'death' of unsuccessful agents.

Chapter 4 provides an overview of historic developments and current issues in the use of simulation models in the social sciences. Here, various examples of the two directions of simulation research will be discussed. However, before discussing simulation in the social sciences, it is important to understand the principles behind different simulation techniques and the relation of such simulations to real world processes. Therefore, Chapter 3 will be devoted to the methodologies that are being used in social scientific simulation models.